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CONSERVATION IDEALS IN THE IMPROVEMENT OF PLANTS

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THE conservation movement had its inception in the wasteful methods practised in the utilization of our national resources, such as our forests and mineral deposits. Alfred Russel Wallace, the great English evolutionist and contemporary of Darwin, has characterized the last century as a century of despoliation of the natural resources of the earth. Our forests have been ruthlessly destroyed until good lumber has reached a very high price, and turpentine and resin in sufficient quantities to meet the world's requirements can scarcely be obtained. In the meantime large areas, denuded of forests, have been changed in climatic conditions and the fertile soils exposed to destructive erosion. Coal beds are being worked in ever increasing quantities and must ultimately be exhausted. The Chilean nitrate-of-soda deposits are approaching exhaustion. We use without thought of the morrow. The conservation movement has extended to the consideration of soil fertility, the proper utilization of water, of water power, of our land domain, and the like.

There is scarcely any source of wealth or of material necessities that has not felt the influence of the conservation movement. If we seek the real source or reason for this inquiry, it is to be found in the rapid increase of our population. The arguments are too familiar to require repetition. We all know that the population of this country and of the world is increasing so rapidly that the time is not far distant when our children will have great difficulty in producing the necessary supplies to maintain life. The teeming millions of fifty and one hundred years hence will not have the rich, virgin lands on which to extend their agriculture, the primeval forests, the apparently inexhaustible coal beds, the extensive deposits of phosphates, nitrates and potash salts, to use in rebuilding their soils. All these sources of supply that we have utilized and found so necessary to life will be gone or rapidly disappearing, and the extent of the demand will meanwhile have increased many fold. It takes no very extraordinary vision to picture the fierceness of the struggle for existence that must soon be reached in the development of the human race. True, there is no immediate concern, as the world will comfortably support a very much larger population; but to preserve future generations from danger requires the wise action of the present and succeeding generations. The careful study of the problem in all its phases is a duty that we can not shirk. The high cost of living at the present time and the simpler living that thousands of families have been compelled to adopt is a reminder of the necessity, even to the present generation, of a careful study of the existing conditions.

The problem of all problems confronting us is the necessity of increasing the production of food stuffs. How can this be done? Obviously the problem can be attacked from many sides, but the side that I desire to emphasize is the conservation of the best breeding stock of plants and animals. This seems a simple matter, but I am sure that the far-reaching possibilities of such conservation are not understood and are beyond our conception at the present time, as our viewpoint is necessarily limited by our present knowledge. Nevertheless, as judged by our present knowledge, the possibilities are so great as to place this factor, I believe, among the important features of the conservation movement.

What do we not owe to our domesticated and improved plants and animals? They are the greatest heritage that has come down to us from our ancestors. If the cultivated varieties and breeds of wheat, oats, corn, cotton, potatoes, cattle, sheep, hogs and horses were all destroyed from the earth and we were forced to go back to wild nature and begin the improvement over again, it is probable that the world would be almost depopulated and that the progeny of the few hardy individuals that survived would, in the centuries that followed, repeat the history of plant and animal improvement that has taken place in the past. Doubtless, however, new plants and animals now unknown to us would be the successful ones in the new evolution. That we now cultivate wheat, oats, corn and the like is probably in large measure due to the accident that attempts to artificially cultivate plants started in regions where the wild ancestors of these plants were native.

In many cases the wild ancestors of our cultivated plants are not positively known. It is not probable that the ancestral types have become extinct, but that the cultivated forms have been so greatly modified that the relationship can not now be recognized with certainty. If *Ægilops ovata,* a wild grass of southern Europe, is the original ancestral form of wheat, as is supposed by some botanists, we have very many native grasses in various parts of the United States, which in an unimproved state have much larger grains and would seem to be equally worthy of cultivation and improvement. If Teosinte (*Euclæna luxurians*), a wild native grass of Mexico, is the original wild ancestor of corn, as is believed by many scientists because of the fact that it is a native of the region where corn was first cultivated, is known to be subject to the same diseases, such as smut, and above all from the fact that it hybridizes readily with corn, we have an unpromising grass, so far as its grain is concerned, which has developed into our greatest of all grain crops.

Are we correct in assuming that all of the valuable plants and animals have already been introduced into cultivation? As a matter of fact, are we not justified in questioning whether the most valuable have been introduced? On sober second thought, does it not seem wonderful that wheat, a native of the Mediterranean region, should remain the best grain crop for a region including the greater part of British America and the United States, of Russia and Argentina and all the broad area where wheat is cultivated? Would it not seem probable that the improvement of the most promising native grain-grasses in these widely different regions would yield new types of grain crops better adapted to the regions and superior to wheat or oats? The great value of wheat and oats lies not in the superiority of the wild types from which they sprang, but to the long years of cultivation and selection to which they have been subjected. A large number of wild grasses occurring in almost every region have comparatively large grains, and if they were capable of improvement, as they doubtless are, they might possibly excel any grains that we now have. The Indian rice or water oat (*Zizania aquatica*) is an illustration of a large-grained wild grass that is probably known to many. Doubtless this could be greatly improved for cultivation in low lands as rice is now cultivated.

The wild wheat grass (*Agropyrum occidentale*) of the great plains region is a very promising type for improvement, as pointed out by Dr. Bessey.[2] In this wild grass we have a head 5 or 6 inches long and developing long, narrow grains much resembling wheat. It is a perennial and grows to a height of 2 or 3 feet. Dr. Bessey says of this plant:

> If our plant had had but a fraction of the careful cultivation and selection which have been given the European species, I am confident that it would have yielded a much more productive cereal than we have in our present varieties of wheat.

Consider further that we have here a perennial that would doubtless yield for several or possibly many years without reseeding, and also that it is a native of the great plains region and thus already adapted to the environment of the great wheat states of the union. Comparing this grass with wheat, which should we expect to be better adapted to the "dry farming" regions of the west?

Several of the wild rye grasses (*Elymus*) have large heads and grains and appear very promising, as do also certain species of the so-called beard-grass (*Andropogon*).

We have only considered the value of these grasses from the standpoint of their grain development; but it is of almost equal importance

[2] Bessey, C. E., "Crop Improvement by Utilizing Wild Species," American Breeders' Association, Vol. II., p. 113.

to consider their value as forage crops for animal food, and here a much greater latitude for selection is possible. A very large number of our native plants should be tested and the most promising improved for forage purposes.

In the development of leguminous crops we have a valuable field of research. Of the many hundreds of legumes, we now cultivate only about a dozen species, such as beans, peas, clover, alfalfa, crimson clover, cowpeas, soy beans and the like, representing a natural adaptation to as many localities. None of the species ordinarily cultivated in the northern United States are natives of this great section. Yet an examination of the botanies shows that some 150 different species of legumes are natives of this section. Would it not seem absurd to assume that our present cultivated species represent the best types for this section, when the most promising of those that the great Master Breeder gave us have not been thoroughly improved and tested? Among the wild native species of *Desmodium, Vicia, Lespedeza* and other legumes, we have a number of promising sorts. We have tested many of these species in comparison with our ordinary cultivated crops and discarded them, but our tests have been of the wild, unimproved, against the improved types. We might as reasonably put gloves on a wild pygmy of Africa and test him on the mat with a trained modern athlete.

Doubtless the mere mentioning of the improvement of native plants suggests to the minds of each one of you some wild plant that you have observed and thought to possess valuable qualities. If our sources of nitrogen supply are to be exhausted soon, we must cultivate more leguminous crops that can gather their own nitrogen and improve the soil in this respect while furnishing crops. We should have leguminous tuber crops to take the place of potatoes, beets and turnips. Nature has given us such wild legumes as the groundnut (*Apios tuberosa*) and the Pomme de Prairie (*Psoralea esculenta*), which already have edible tubers and which could doubtless be developed into very valuable cultivated plants by a few years of breeding.

Dr. J. Russell Smith,[3] of the University of Pennsylvania, has emphasized the importance of breeding tree crops, and here we have an inexhaustible field of experimentation. We should breed chestnuts, walnuts, hickories, oaks, beeches, hazelnuts, and the like, in order to improve them for the use of man and for growth as stock food. Many hundreds of thousands of acres of rough, hilly land unadapted for cultivation would be suited for the growth of such crops.

The possibilities of breeding tree crops are well illustrated by the excessive increase in vigor, rapidity of growth and size of fruit obtained by Burbank in a hybrid between the English walnut (*Juglans*

[3] Smith, J. Russell, "The Breeding and Use of Tree Crops," American Breeders' Association, Vol. I., p. 86.

regia) and the California black walnut (*J. californica*). Burbank says:

> The hybrid grows twice as fast as the combined growth of both parents. The leaves are from 2 feet to a full yard in length. The wood is compact, with lustrous, silky grain, taking a beautiful polish, and as the annual layers of growth are an inch or more in thickness and the medullary rays prominent, the effect is unique.

Another of Burbank's walnut hybrids obtained by crossing the black walnut with pollen of the Californian black walnut, produces fruit of very much larger size than either parent. When we come to plant large areas to trees, as we are rapidly coming to do, imagine the immense value to the world if we could plant hybrids of rapid growth such as Burbank's walnuts.

Who has tried to produce hybrids of maples, oaks, hickories and pines to get quick-growing hybrids for planting purposes? Who has hybridized such trees to get larger and better fruits? The world should not be compelled to wait much longer for such improvements. We need the improved stock for planting. Some trees live a century before they reach young manhood.

Persimmons, pawpaws, huckleberries, elderberries, hawthorns and hosts of other native fruits are well worth improvement and might be utilized not only for human food but for hogs, sheep and poultry.

Mr. Frank Babak, of the Department of Agriculture, has recently shown that the black sage (*Ramona stachoides*), a wild California plant, and the swamp bay tree (*Persea pubescens*) of the southeastern United States, both contain a fairly high percentage of camphor and could be utilized for the manufacture of this valuable product. Doubtless these plants could, by breeding, be adapted to cultivation and the percentage of camphor increased.

The value of improving native plants has been strikingly demonstrated by the amelioration of our native grapes. The attempts of our early ancestors in America to grow European grapes uniformly met with failure, and finally, as a last resort, attempts were made to cultivate the native wild types. The marvelous success achieved, which has resulted in the production of a large number of fine varieties, and established vine growing in the eastern and central United States, is one of the important achievements of our many-sided national history.

The same was true in the case of the gooseberry. The European varieties failing to succeed here because of the mildew, the small fruited native species were introduced into cultivation, and the size of the fruits has been more than quadrupled in the improved sorts. Plums, raspberries, blackberries and the like furnish other illustrations of interest.

The native wild beggar weed (*Desmodium tortuosum*) has been introduced into cultivation in Florida, and, without breeding or improvement of any kind, has in a few years won a permanent place in southern agriculture.

It may be argued that the improvement of our native plants would be too slow to justify attempts in this direction. I should answer that nothing is too slow that will pay. Nations bond themselves for hundreds of millions of dollars to carry on a war of the present, which bonds their children must pay sometime in the future, and for no compensation except to maintain the pledged honor of the nation. While breeding is slow when judged from the "get-rich-quick" standpoint of modern Chicago, it is not slow when compared with the life of a nation and from the standpoint of permanent welfare. Within the memory of man the tomato has been introduced into cultivation and advanced in size from a fruit of $\frac{3}{4}$ of an inch in diameter to our fine modern fruits, some of which grow as large as 4 inches in diameter.

A striking illustration of this nature is furnished by the experiments that the writer has conducted in the improvement of timothy. Timothy was introduced into cultivation about 1720, nearly two centuries ago. For many years it has been extensively grown, but, until recently, no attempts have been made to develop improved races. In experiments conducted by the Cornell Experiment Station, timothy seed was obtained from a large number of places in this and foreign countries, from which about 18,000 individual plants were grown and the different types studied and isolated. As a result of 9 years of work, some 200 different races have been secured that show a very wide range of characters, and vary from dwarfs to giants in size. A test of the yields of 17 of these new varieties in comparison with the best timothy seed that could be purchased in the market was made in 1910, and also in 1911. In 1910 the average yield of the 17 new sorts was 7,451 pounds per acre and that of the 7 check plats of ordinary timothy was 6,600 pounds per acre; an average increase of 851 pounds per acre in favor of the new varieties. In 1911 the average yield of the 17 new sorts was 7,153 pounds per acre and that of the 7 check plats was 4,091 pounds per acre; an average increase of 3,062 pounds per acre in favor of the new varieties. Four of the high yielding sorts in 1911 gave an increased yield of over 2 tons per acre, or practically double the average yield of the checks, which is an astonishing figure and can be explained only by the fact that timothy has never been improved by breeding and still consists, as generally cultivated, of a motley array of many different types.

Hay is one of the largest agricultural crops of the United States, outranking all other crops, except corn, in total value of production. In 1910, according to the statements issued by the United States Department of Agriculture, there were grown in the United States 45,691,000 acres of hay, which yielded a crop having a farm valuation of $747,769,000. No statistics are available from which we can determine what proportion of this hay was timothy, but the writer believes that we may safely conclude that at least one third of the entire hay crop of the country is timothy. If this is true, the timothy crop of the United States in 1910 had a valuation of over $249,000,000. In the two years during which tests have been made, the 17 new sorts gave an average increased yield of slightly over $36\frac{3}{5}$ per cent. above ordinary timothy. A $36\frac{3}{5}$ per cent. increase in the valuation of the timothy crop as above estimated would give us over $90,000,000 as the estimated annual gain in the value of the crop which would be obtained if new sorts equally as good as these could be used throughout the country.

The rapid development of the science and art of breeding places us to-day in position to secure improvements much more rapidly than has been done in the past. It would not be astonishing if from 25 to 50 years of careful, intelligent breeding would accomplish with a wild plant what has required many centuries under the crude methods of our ancestors.

It may be asked why we should be in haste to take up the improvement of our native plants. In answer to this it may be stated that profound changes, such as we desire and must have, require time for their accomplishment. The potato and the tomato did not reach their present perfection at one bound. A number of intermediate stages or improvements were first necessary. The strawberry and the gooseberry did not reach their present size by one mutation, but several intermediate sizes were first necessary. Improvements apparently come by sudden leaps or mutations, and each of these paves the way for further development that might never be possible without the first improvement.

In breeding, the time element is the limiting factor of importance. No permanent improvement of value can be obtained in a day, and no time should be lost in beginning, on a scale commensurate with its importance, the improvement of our native plants of promise. We must conserve time and fulfill our duty to the succeeding generations. Why is it that such a small proportion of our lands are cultivated? According to the 1900 census, of the 1,900,000,000 acres of land in continental United States only 838 millions of acres were in farms, and of this area over 50.6 per cent. was unimproved land. The sterile sandy lands, and the low, wet lands, the stony lands and the hill lands, the mountain lands of high altitude and the barren lands of deserts lacking water, and the like, all uncultivatable and largely worthless for crops at present grown, make up far the larger part of our vast domain.

Travel through the high, hilly and mountainous regions of New York, Pennsylvania, Maryland, Virginia, North and South Carolina and Georgia, and you find vast areas covered mainly with a low growth of young trees and bushes, the main forests having been removed. The same is true of many extended areas in the central and western states.

The utilization of these waste lands forms one of our great national problems, and the beginning of the solution of the problem rests in finding the crops best adapted to such areas or in all probability in breeding crops that will be adapted to them. The necessity of using these waste lands in the near future is evident. Shall we plant them to forest? Certainly much of this land should be in forest, or in tree crops of some sort, but we want tree crops, at least in many cases, that will return food as well as shelter. The Italian yield of chestnuts is said to average 12 bushels per acre, and J. Russell Smith states that "the value of European mountain-side chestnut orchards equals acre for acre the Illinois corn belt." The kinds of trees to plant in such areas for wood, fruit, sugar, starch, camphor or forage require careful study and the proper breeding in order to secure the best sorts possible.

But this is not all of the problem. Grain, forage and special fruit crops, not necessarily forest trees, require to be as carefully considered, and here again breeding to secure good races adapted to the conditions will be the key note of success. All this requires time, and the generations to follow will not have the time and certainly not the money if they do not repudiate our war debts. The work should be started immediately in order to obtain the results by the time conditions demand them. When I urge this as one of the important national problems of conservation, I speak not without some authority. My life has been given to agricultural work in various parts of the United States. My boyhood on an Iowa farm gave me a knowledge of the rich prairie regions of the west. My education in the University of Nebraska and Washington University, Missouri, extended that knowledge. My sixteen years of service in the National Department of Agriculture, working with cotton and oranges in Florida, Georgia, Alabama, Mississippi and Texas, taught me southern conditions and demands, and now my experience of the last five years in Cornell University, associated with that master agriculturist, Dean L. H. Bailey, has broadened my horizon to at least some conception of the field of agricultural education.

As to the possibilities of producing the suggested improvements in plants, it again may be granted that I can speak with some degree of authority in view of the fact that the great cotton, corn, timothy, orange and pineapple industries have, at least in certain places, felt the influence of new varieties that have gone out from my laboratory. I say this not to extol myself, as any man in my place with my opportunity could have accomplished the same results and many would have done very much more. I say it simply to lend weight to my statements.

I can by no words of mine present this problem in its importance as I see it. In no way, probably, can my efforts stir the nation to a recognition of the necessities of this case, so that action will not be too long delayed. Recognizing the urgency of the problem as I do, however, I should be remiss of my duty did I not use such powers and gifts as have been given me to urge forward a project that sooner or later will be recognized as one of the keystones of the conservation movement.

The materials for the consummation of the ideals I have presented are all around us. The brawn and brain for the service is awaiting the opportunity. The service will be long and difficult, however, and the servant must live while engaged in the task. Only by long, consecutive years of service can the highest ideals be reached. Men must consecrate their lives to this achievement. The service will be pleasant and the scientific results gathered from year to year will repay the worker, but means must be found to place the investigator beyond the temptation of other employment, as permanency of tenure in such work will be of the highest importance. It is a work for the state and the nation, but I fear they will be too slow to recognize the long-time requirements of the work. Political institutions demand too quick results. I feel that the most hopeful method of accomplishing some of the ideals outlined is through endowed institutions. To what more serviceable task could benefactions be devoted than to the solution of such problems, and what type of institution would return more credit to the donor? Institutions to conduct such work could be tied up with some of our great universities to establish the proper scientific relationship, and should be in such close cooperation with these universities that graduate students could be utilized in connection with the investigations and trained in the service.

In summarizing this discussion I may say that to one unfamiliar with the possibilities of breeding the outcome of such experiments may appear doubtful. We need no lamp to guide us except that of experience. When we realize the little promise exhibited by the native grapes, tomatoes and potatoes from which our cultivated sorts have sprung, we gain a conception of the tremendous increases that can be brought about by a century of cultivation, even when the breeding is of desultory nature. Couple with a century of time, aye fifty years, the skill of trained breeders, and what might we not accomplish. The greatness of the possibilities stretches before the enthusiastic breeder as his mind spans the years filled with the battles of conquest and achievement in the building up of new industries, like a panorama of the wars and struggles in the building of a nation. Man's creative genius is touched. It appeals to him in its vastness as a challenge. The trained man in the field of breeding feels the certainty of his power. He longs for the conquest.